Experimental Probes of Information Registration and Variance Suppression

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Abstract

This document presents a set of experimentally accessible probes designed to evaluate the central claims of the framework introduced in *Information Registration as a Physical Accumulation Mechanism*. The core hypothesis is that physical stability and persistence arise from the repeated, irreversible registration of state information into durable media, producing time-integrated constraints on system evolution. We outline falsifiable experimental designs across quantum, biological, and artificial systems to test whether variance suppression scales with accumulated registration rather than peak interaction intensity. No experimental results are claimed. This appendix serves as a bridge between theoretical formulation and empirical investigation.

1 Purpose and Scope

The parent paper proposes that persistent physical structure emerges from accumulated information registration rather than from observation, interpretation, or instantaneous force. This appendix isolates that mechanism and translates it into concrete experimental tests.

The objective is to determine whether:

1. Stability correlates with accumulated registration,
2. Variance suppression follows a predictable functional form,
3. Durable records matter more than transient signal intensity.

This document makes no metaphysical claims and does not assume any particular interpretation of quantum mechanics, cognition, or computation.

2 Key Quantities

We summarize the quantities under investigation:

- **Registration Rate** $\mathcal{R}(t)$: the irreversible embedding of state information into a physical medium.

- **Accumulation Functional**

$$A(T) = \int_0^T \mathcal{R}(t)\, dt$$

- **Variance Suppression Law (Hypothesized)**

$$\sigma^2(A) = \sigma_0^2 e^{-\kappa A}$$

where κ is a system-dependent constant.

3 Prediction 1: Repeated Low-Intensity Registration Stabilizes Faster

3.1 Hypothesis

Systems exposed to sustained, low-intensity information registration stabilize more rapidly than systems receiving equivalent total energy delivered in transient bursts.

3.2 Quantum Probe

- System: Bose–Einstein condensate or optical lattice
- Condition A: Repeated low-power interactions
- Condition B: Single high-power interaction (equal total energy)
- Observable: Coherence time via interferometry
- Expected Outcome: Faster variance suppression in Condition A

3.3 Biological Probe

- System: Hippocampal slice cultures
- Condition A: Repeated low-amplitude stimulation
- Condition B: Single high-amplitude burst
- Observable: Long-term potentiation persistence
- Expected Outcome: Greater synaptic stability in Condition A

3.4 Artificial Probe

- System: Recurrent neural network
- Condition A: Many small gradient updates
- Condition B: One large gradient update

- Observable: Error variance after perturbation
- Expected Outcome: Reduced catastrophic forgetting in Condition A

4 Prediction 2: Stability Scales with Accumulation, Not Peak Intensity

4.1 Hypothesis

Stability correlates monotonically with the accumulated registration $A(T)$ regardless of instantaneous interaction strength.

4.2 Test Criterion

Experimental data should be plotted as σ^2 versus $A(T)$ and evaluated against the hypothesized exponential suppression law. Failure to observe monotonic dependence falsifies the model.

5 Prediction 3: Disruption of Records Increases Variance

5.1 Hypothesis

Disruption or erasure of persistent records increases variance even when signal intensity remains high.

5.2 Test Examples

- Quantum systems: Erasure of environmental records restores interference
- Biological systems: Blocking consolidation mechanisms degrades memory
- Artificial systems: Corrupting persistent storage increases forgetting

6 Prediction 4: Durable Registers Contract State Space

6.1 Hypothesis

Systems possessing durable recording media exhibit reduced accessible state-space relative to otherwise identical systems lacking such registers.

6.2 Observable

State-space contraction may be measured through entropy proxies, trajectory diversity, or phase-space volume estimates.

7 Interpretation Criteria

Support for the proposed mechanism requires:

- Monotonic scaling of stability with $A(T)$
- Insensitivity to peak intensity at fixed accumulation
- Increased variance following record disruption

Failure of any criterion constrains or falsifies the framework.

8 Conclusion

This appendix translates a theoretical accumulation-based framework into experimentally testable form. The proposed probes rely exclusively on existing techniques and require only a reframing of independent variables. If supported, the results would unify stabilization phenomena observed across quantum measurement, biological memory, and artificial learning under a single physical mechanism based on persistent information registration.

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